



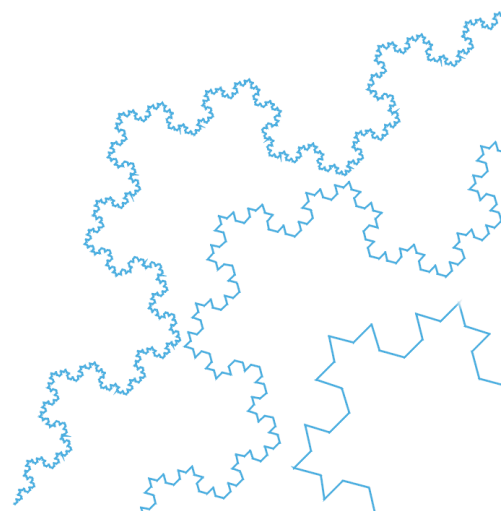
**Cambridge Econometrics**  
Connecting you to the future



# **The Benefits of Greener Business**

**A draft final report submitted to  
the Environment Agency by  
Cambridge Econometrics  
and AEA Technology**

**April 2003**



Cambridge Econometrics  
Covent Garden, Cambridge CB1 2HS  
Tel +44 (0)1223 460760 Fax +44 (0)1223 464378  
Email [sj@camecon.com](mailto:sj@camecon.com)  
Website [www.camecon.com](http://www.camecon.com)

AEA Technology  
Harwell B329  
Didcot, Oxon OX11 0QJ  
Tel +44 (0)1235 821111 Fax +44 (0)1235 433986  
Email [martin.gibson@aeat.co.uk](mailto:martin.gibson@aeat.co.uk)  
Website [www.aeat-env.com](http://www.aeat-env.com)

## CONTENTS

---

	page
List of Tables	iv
List of Figures and Charts	v
Preface	vi
Conventions	vii
Executive Summary	viii
Chapter 1: Introduction	1
1.1 Objectives	1
1.2 The wider context	1
Chapter 2: Sources and Methods	4
2.1 Estimating the potential savings from improved use of resources	4
2.2 The Envirowise case studies	5
2.3 Summary of methodology for drawing estimates from the case studies	6
Chapter 3: Results of generalising the Envirowise case studies by industry	8
3.1 Overall results	8
3.2 Results by broad manufacturing sector	10
Chapter 4: Results of generalising the Envirowise case studies by region	13
4.1 The key findings	13
Chapter 5: Macroeconomic estimates of the costs of unproductive use of resources	15
5.1 The key findings	15
Chapter 6: Recommendations to improve the evidence base	16
Chapter 7: References	17
Appendix A: Methodology for deriving estimates from the Envirowise case studies	18
Appendix B: Supplementary tables and charts	21

## LIST OF TABLES

---

	page
Table 3.1: Annual savings in manufacturing in England and Wales - sensitivity to alternative assumptions	8
Table 3.2: Annual savings from waste management process improvement in manufacturing in England and Wales	10
Table 3.3: Size distribution of firms in Envirowise case studies	11
Table 3.4: Employment coverage of Envirowise case studies	11
Table 4.1: Annual savings in central case from waste minimisation process improvement in manufacturing industry - English regions and Wales	13
Table B1: Breakdown of annual savings from waste minimisation process improvement in central case - manufacturing sectors	23
Table B2: Breakdown of annual savings from waste minimisation process improvement in UK manufacturing industry - English regions and Wales	24
Table B3: Waste arisings across waste producing sectors - English regions and Wales	25
Table B4: Net present value of savings from waste management process improvements in manufacturing in England and Wales - sensitivity to alternative assumptions	26
Table B5: Net present value of savings from waste management process improvements in manufacturing in England and Wales as a percentage of sectoral GVA	26
Table B5: Net present value of savings from waste management process improvement in manufacturing in England and Wales	27

## **LIST OF FIGURES AND CHARTS**

---

	page
Figure 1: Savings from resource productivity	ix
Chart 3.1: Annual savings by manufacturing sector and as a proportion of GVA	9
Chart 3.2: Distribution of annual savings per employee from Envirowise case studies	10
Chart 4.1: Share of annual savings across the English regions and Wales	14
Chart 4.2: Annual savings by region and as a proportion of manufacturing GVA	14
Chart B1: Distribution of net present value of savings per employee from Envirowise case studies	22
Chart B2: Distribution of payback periods from Envirowise case studies	22

## PREFACE

---

This report has been produced by Cambridge Econometrics and AEA Technology for the Environment Agency.

The following have contributed to the estimates and the body of the report:

Ben Etheridge (Cambridge Econometrics)

Sudhir Junankar (Cambridge Econometrics)

Richard Lewney (Cambridge Econometrics)

Martin Gibson (AEA Technology)

Jude Murphy (AEA Technology)

The contributions of other Cambridge Econometrics and AEA Technology staff are acknowledged.

Cambridge Econometrics

April 2003

## CONVENTIONS

---

Initials Used:

CE	Cambridge Econometrics Limited
AEAT	AEA Technology Limited
ABI	Annual Business Enquiry
GVA	Gross Value Added
NPV	Net Present Value
SIC	Standard Industrial Classification
HMT	Her Majesty's Treasury
DTI	UK Department of Trade and Industry
ONS	Office of National Statistics
pa	per annum
pp	percentage point
bn	billion
m	million

## EXECUTIVE SUMMARY

---

### The key results

- There appear to be significant gains, both for business and for society at large, to be had from investment in resource productivity. These gains would help both to raise the UK's productivity (value added per hour worked) and to make progress towards a more sustainable path of development.
- If manufacturers invested in best-practice *waste minimisation* techniques they could achieve around £2-2.9bn savings in annual operating costs. To put this figure in context, this represented 1¼-2% of UK manufacturing value added and 5-7% of profits in 2000.
- This supplements potential savings from other kinds of investment in resource productivity. The Cabinet Office Strategy Unit's Energy Review in 2002 estimated that the implementation of cost-effective measures to promote energy efficiency could save £1.8bn in industry and £7.3bn for all sectors of the economy.
- Typically the case studies conducted under the Government's Envirowise programme suggest that the average payback period on the investment is twelve months or less<sup>1</sup>. This compares with the 2-4 years cited for energy efficiency investments by the Cabinet Office Strategy Unit's *Energy Review*.
- The annual savings estimates from waste minimisation made in this study are likely to understate the potential benefits to businesses from a more efficient use of resources because they include only carefully audited 'good housekeeping', easily identifiable savings found to date from process changes.
- Firms may underestimate the potential savings by focusing only on their waste disposal costs. Figure 1 shows that almost 60% of the savings come from lower purchase costs of materials that do not end up in the final product.
- Firms also incur costs of processing and handling these 'unnecessary' materials and in some cases these are considerably larger than the purchase costs of materials. Case studies of various sectors within manufacturing show that the value of companies' processing costs embodied in their waste were almost double the purchase cost of materials.
- The case studies were carried out prior to the increase in the Landfill Tax announced in the Budget. The incentives for curbing waste disposals are therefore now higher.

### Objective of the study

- This study, commissioned by the Environment Agency and carried out by Cambridge Econometrics and AEA Technology, presents estimates of the costs to manufacturing businesses of failing to adopt best-practice methods for the productive use of resources and waste minimisation.

<sup>1</sup> Envirowise is a UK Government programme which aims to improve the environmental and economic performance of UK business by helping them to use resources more efficiently.

- Every manufacturing plant has its own unique characteristics. A precise estimate of the savings to be gained from investment in improved resource productivity would require a feasibility study for each plant. The aim of this study has been to establish broad estimates of the savings that would be achieved if the experience of firms examined by the Government’s Envirowise programme were to be replicated elsewhere.

**The sources and the methodology used**

- The analysis was based on some 65 case studies/histories of companies under the Envirowise programme.
- The case studies were reviewed:
  - to derive data on costs and cost-savings required for a annual savings calculation for each process improvement
  - to assess the extent to which the data are representative and the scope for replication to other firms
- Various grossing-up methods were applied to derive a central estimate of potential saving in each industry group in England and Wales as a whole. This required various assumptions about the extent to which the estimates from case studies were adequate to allow generalisation. The central estimates were then tested for robustness by varying key assumptions.
- Having established the overall England and Wales industry estimates, the results were allocated to the English regions and Wales on a pro-rata basis industry by industry according to each region’s share in the GB total for employment.



# 1 INTRODUCTION

---

## 1.1 Objectives

The objectives of the study were:

- to produce an ‘order of magnitude ‘ range estimate of the costs to business of the unproductive use of resources by sector, by English region and Wales and an analysis of the significance of these costs in terms of the economic performance of the UK
- to provide an explanation of the methodology and an analysis of the robustness and sensitivity of the results
- to note the wider context of the work in relation to international developments and current national resource productivity programmes

## 1.2 The wider context

The stylised facts about the extent of waste generated in England and Wales are given in Appendix B Table B3 and formed the background to our study. Industry accounted for around 28% (50 mt) of the total controlled waste arisings of 181.6 mt in 1998-99 covering also special waste, commercial, household/municipal and construction/demolition sources. The regional breakdown of industrial waste shows that London accounted for just 2.7 mt at the bottom end while Yorkshire and the Humber had the highest figure, at 9.5 mt.

This study focuses on the potential gains to business from the more efficient use of resources, but this needs to be set against the background of:

- market failure and inefficiencies at the level of the individual business associated with information failures or asymmetries which mean that cost savings are not realised
- the broader contribution of improving resource productivity to the Government’s objective of increasing UK productivity and closing the gap with main competitor countries

### **Market inefficiencies**

Market failures or asymmetries can arise from a lack of information available especially to small businesses, which can also be exacerbated by inadequate environmental accounting. This can result in cost savings from the more efficient use of resources not being taken up, although such waste minimisation measures may be profitable and yield a relatively quick payback on the initial outlay. In addition there are arguments in terms of strategic environmental management (SEM) that provide a theoretical rationale for the existence of such gains (Goldstein D, 2002). This approach incorporates into firms’ core strategies the transformation of products and processes that they believe an

environmentally-concerned society will increasingly demand. There are significant cost savings and market opportunities to be discovered from reducing environmental impacts.

**The  
Government's  
productivity  
agenda**

An improvement in resource efficiency implies higher value added for unchanged employment, or an increase in the Government's preferred measure of productivity. It would therefore support the Government's objective of closing the productivity gap with key industrial competitor countries in the EU and particularly the US. The Energy White Paper, published in February 2003, emphasised the need to promote resource productivity as part of the effort to boost UK productivity and competitiveness (DTI, 2003). It referred to energy and waste as representing the 'two policy blocks', that were core elements of a Sustainable Consumption and Production (SCP) future. The Government has also signalled its intention in the coming months to develop a wider strategic overview of this policy area, building on the work of the Strategy Unit's report discussed below.

The Chancellor's Budget statement on 9 April 2003 highlighted the need to close the UK's productivity gap in which higher resource productivity would play a important part. The Budget 2003 report restated the aims of the Government's strategy for an environmentally-sustainable economy which were:

- the promotion of the efficient use of resources
- the effective management of waste

The report notes that the waste stream contains resources which can be re-used or recycled to deliver economic value, resulting in greater resource efficiency (HMT, 2003).

**The business  
perspective on  
resource use/  
environmental  
impact**

Businesses focus on delivering to the customer. In today's internationally competitive marketplace, companies strive to be as efficient as possible. Given this situation, it may seem surprising that most companies could use resources more efficiently. However, numerous initiatives have shown that even the best companies can save money by improving resource use and producing less waste. This study seeks to estimate the potential cost savings if every company were as efficient as the best.

The importance of the effect of business activities on the environment has long been recognised. However, until relatively recently, business activities were generally thought to be in conflict with environmental constraints. This perception has changed considerably over the past decade or so. Many businesses now recognise that more efficient use of resources reduces both their own costs and their environmental impact. This is one of the reasons that businesses were well represented at the World Summit on Sustainable Development in Johannesburg in 2002. The Summit agreed on ten-year action plans in which businesses will play a critical role in many aspects of delivery.

On the UK front, the benefit of increasing the efficiency with which we use resources was recognised by the Cabinet Office's Strategy Unit in its report in November 2001 (Cabinet Office, 2001). This highlighted the potential benefits to the UK economy of increasing resource productivity, which can:

- help deliver sustainable prosperity

- deliver benefits to the economy and society where natural resources are an important inputs to economic activity by playing a key role in cutting costs, improving overall productivity and reducing waste and pollution
- save money for businesses and households, though innovation in new technologies, new processes and in the management of productive activity will be required

Thousands of UK companies already recognise the cost saving opportunities that come from using resources as efficiently as possible. Many of these have taken part in one of over one hundred waste minimisation clubs in the UK. Many others are featured in case studies produced by the Envirowise Programme.

The UK Government's Envirowise programme was set up to help companies improve resource efficiency. One of the ways in which it does this, is by producing case studies of the resource efficiency methods used by a range of companies. The case studies show the financial and environmental benefits of focusing on improving the use of raw materials and consumables to reduce the production of waste. It is recognised, however that small businesses face particular problems and barriers as they lack the information, expertise and support available to larger firms. The programme is estimated by AEAT to have helped companies to save £217m per annum or a total of £719m up to March 2001, compared with a cost of £38m.

Manufacturing companies usually have the most to gain from improved resource efficiency. Often the true cost of waste in manufacturing is dominated by the cost of raw materials that do not go into the product. For this reason, this study focuses on manufacturing industries, but many services can also make savings through resource efficiency.

## 2 SOURCES AND METHODS

---

### 2.1 Estimating the potential savings from improved use of resources

The potential savings from adopting best-practice methods for the productive use of resources can, in principle, range from easily identifiable savings to more intangible, though nonetheless genuine, benefits available to businesses. The savings that can be realised are as follows.

#### **Costs of raw materials and waste disposal**

The Envirowise case studies capture the carefully audited ‘good housekeeping’ savings from process improvements that lead to reduced use of raw material inputs, lower waste disposal costs and reduced costs from substitution. These annual savings have been estimated with reasonable accuracy in this study, but are considered likely to form only a part of the total potential gains from improving resource productivity.

#### **Value added to raw materials**

There are also additional savings from lower costs of processing/handling raw materials, (and including other resources such as energy, labour and lower depreciation) that typically are not measured in Envirowise case studies. Such cost savings are more difficult to measure and are typically not readily identified by firms, but a study of waste reduction in industry in Bedfordshire (Oakdene Hollins, 2002) shows that such cost savings can be large.

When a semi-finished product is discarded to landfill, the embedded/added value of resources it contains tends to be disregarded by manufacturing businesses. Only the costs of raw material purchases and waste disposal tend to be recognised in company accounting systems. Other estimates made by Oakdene Hollins from case studies of companies involved in schemes in Aylesbury Vale, Bedfordshire and Milton Keynes indicate that the median value of businesses’ processing costs embodied in their waste was almost double the purchase cost of materials (Oakdene Hollins, 2003). The schemes included 21 small to medium-sized companies, employing from around 10 to 500 people, and covered a range of low and high value-added sectors in manufacturing. Within the schemes the estimates are broad approximations as they were derived on a company-by-company, and not on an individual plant, basis. The value of the waste at the point of rejection in a production process was measured using the principles of activity-based costing. This involved the calculation of the cost per unit of production of each upstream operation and multiplying this figure by the number of units rejected.

It is difficult to generalise from this type of study to estimate cost savings in manufacturing as a whole as these depend greatly upon the type of production process. However, this analysis does show that the costs identified in the Envirowise studies do not cover the full value of the savings from improved resource productivity, and for some processes the difference is likely to be large. With increasing pressure on UK manufacturers to move up the value-added chain in order to compete with lower-cost overseas producers, the relative importance of these kinds of savings compared with the cost of inputs and disposal is likely to grow.

**Management time** There may also be savings associated with reduced management time which again are difficult to measure.

**Energy** The Envirowise case studies focus on the opportunity for cost savings from only one part of the resource productivity agenda, namely waste minimisation. There are also large savings to be made from improvements that focus on improving energy efficiency. Estimates in Annex 6 of the report by the Strategy Unit of the Cabinet Office suggest that the adoption of cost-effective energy efficient practices could yield cost savings (Cabinet Office, 2002) of some £1.4bn savings in manufacturing industry, representing 18% of the total of £7.3bn achievable from all sectors of the economy. In the business sectors the investments stimulated by Action Energy are estimated now to save over £800m annually, with a typical payback of two to four years.

**Sectors outside manufacturing** Other, non-manufacturing, sectors, which account for four-fifths of the economy can also make savings through improved resource efficiency. However, cost savings are easier to identify in manufacturing, because here the cost of waste is dominated by the cost of raw materials not going into the product.

## 2.2 The Envirowise case studies

**Envirowise** Envirowise produces *case studies* of techniques that can be replicated by other companies. Each case study is designed to help a particular industry sector with a particular technique. Every case study has a unique message in helping to improve resource efficiency. This means that each case study will typically either show a different technique or cover a different sector of industry.

In producing case studies, Envirowise works with industry bodies to identify processes where efficiency could improve. It then identifies a company that has improved the process as a subject for a case study. Envirowise audits the company's procedures to determine the cost and environmental savings made and then publicises the findings.

Each case study has to be justified on the basis of the savings it is likely to help stimulate. To do this, the Envirowise team uses its knowledge of each sector to assess how many companies within the target sector could adopt the change in technique. Envirowise undertakes marketing designed to reach a proportion of these companies. At the same time, a conservative estimate is made of the average savings that will be made by companies that adopt the technique.

**Typical savings identified** The savings that in principle can be identified in the case studies are:

- reduced purchase of raw materials
- one-off savings
- reduced costs of processing inputs that are ultimately wasted
- reduced costs due to substitution

- sale of recovered product
- reduced management costs
- reduced waste disposal costs
- unattributable costs

In addition to detailed case studies, Envirowise also produces case histories. Each case history reports on a single company and usually covers the generic messages from waste minimisation club activities (a club being a group of firms that invests in shared infrastructure). The auditing of case history companies is commensurate with the amount of detail they contain. The cost savings realised by companies that replicate the approach in a case history can be very variable. Therefore, in determining the likely savings based on these case histories, a very conservative estimate of average savings is used.

### **Principles for generalising from the case studies**

In the current study, we have estimated the number of companies that have yet to adopt the approach within each case study. We have assumed that the average cost savings figure initially identified by Envirowise remains valid.

The potential for replicating the savings identified in Envirowise case studies and case histories depends on the number of companies that could make similar changes and the savings each company could make. The detailed case studies usually cover specific processes and, by talking with industry stakeholders, the Envirowise team can identify reasonably reliably the number of companies that could adopt the approach. Knowledge of actual replication is gained from surveys and market intelligence. For this study, we have assumed that replication to date is the highest estimated by Envirowise, so the potential for further replication is a conservative estimate to avoid unjustifiable optimism.

The number of companies that could replicate the processes given in case histories is hard to determine. The approaches given in case histories may be replicable across companies in many sectors. Also, as the approaches tend to be fairly general, a number of case histories could be relevant to each company covered but the improvements could only be undertaken once. To help ensure that this study only counts potential savings within a company once, the number of companies that could replicate case history savings has been restricted initially only to companies within the sector covered by the case history.

## **2.3 Summary of methodology for drawing estimates from the case studies**

This section summarises the methodology used to draw from the Envirowise case studies an estimate of the value to manufacturing of ‘untapped’ savings in greater resource productivity. The method is explained in detail in Appendix A, but its essential features can be summarised as follows, using the example of a single case study.

One case study contains data on the savings by a firm in group 19.3 (manufacture of footwear) according to the 1992 Standard Industrial Classification (SIC 92) of economic activities. Using these data, and information on how widely the process could be replicated, we scale up the value of these potential savings to the rest of group 19.3. We then use disaggregated GB employment data to allocate these savings by region. Having identified group 19.3 as part of subsection DC (manufacture of leather and leather products), we evaluate potential savings for those groups in the subsection not covered by case studies: 19.1 and 19.2. We then sum the value of untapped savings for 19.1, 19.2 and 19.3 to the savings for subsection DC; we then sum all the subsections to form the total for manufacturing by region.

### 3 RESULTS OF GENERALISING THE ENVIROWISE CASE STUDIES BY INDUSTRY

#### 3.1 Overall results

The overall annual savings estimates, which are derived from the Envirowise case studies suggest that manufacturing industry in England and Wales could achieve, in the central case, some £2-2.9bn in cost savings from resource productivity process improvement. To put this figure in context, this represented 1¼-2% of UK manufacturing value added, and 5-7% of the sector's profits in 2000. The details are given in Table 3.1.

**The key assumptions underlying the central estimate**

The calculation of the central estimate requires a number of assumptions:

- In those case studies where no explicit figure was cited, the scope for replication for the process improvement to other firms was set at 20% (compared with the range of replication rates of 5-100% that are quoted). In other words, 20% of all firms (by employment) in the same sector were considered capable of achieving this saving.
- For manufacturing sectors not covered by case study data, the median of the distribution of annual savings per employee (£365) was used to estimate the savings that might be achieved by a process improvement (see Chart 3.2 which shows the distribution). We assume only one 'typical' process improvement per sector, whereas the Envirowise case studies include examples of more than one possible improvement per sector. We also adopt a cautious estimate of the extent to which

**TABLE 3.1: ANNUAL SAVINGS IN MANUFACTURING IN ENGLAND AND WALES - SENSITIVITY TO ALTERNATIVE ASSUMPTIONS<sup>1</sup>**

	Low	Central	High £bn 2000
Operating costs	0.11	0.13	0.16
Savings	2.07	2.39	3.04
Net savings	1.96	2.27	2.88
Industry indicators			
- Manufacturing gross operating surplus <sup>2</sup>	40.59	40.59	40.59
- Manufacturing GVA <sup>2</sup>	153.67	153.67	153.67
Net savings as % of industry indicators			
- Manufacturing gross operating surplus <sup>2</sup>	4.83	5.58	7.10
- Manufacturing GVA <sup>2</sup>	1.28	1.47	1.87

Note(s) : 1 Variation of assumptions: Low: lower quartile of annual savings per employee, Central: median of annual savings per employee, High: upper quartile of annual savings per employee (after adjustment for replicability).  
2 Data are for UK.

Source(s) : CE, AEAT, ONS.

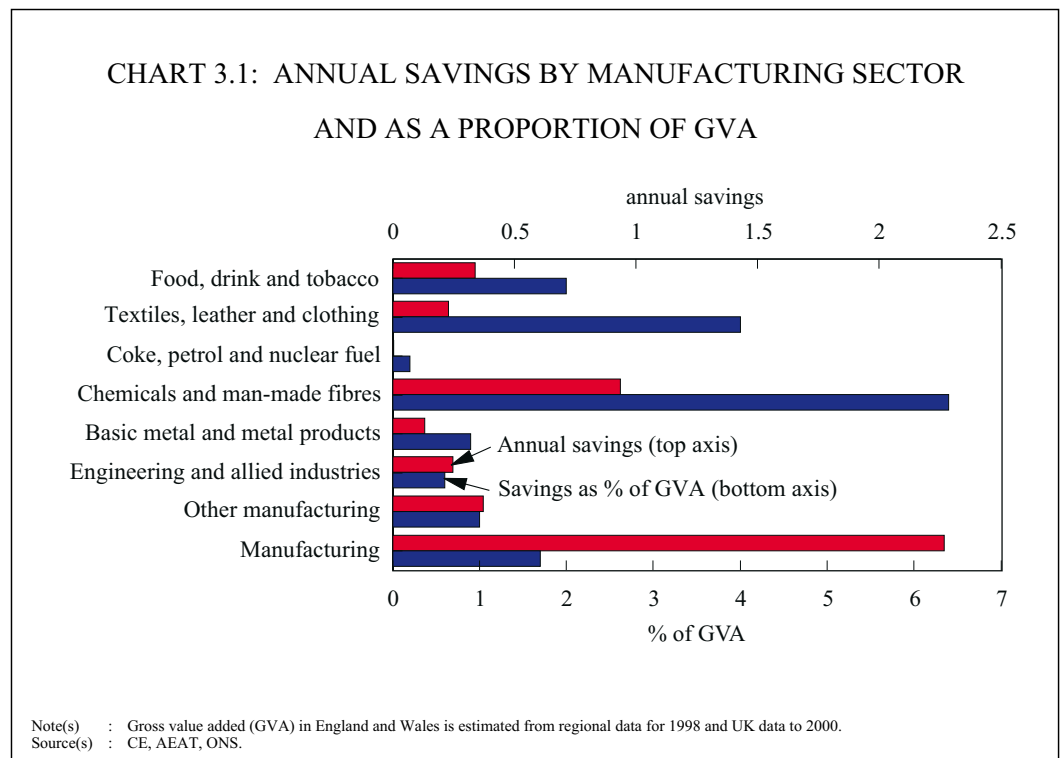
this process improvement could be applied throughout a given sector, reducing the ‘effective’ rate of savings per employee to £225.

These assumptions produce a low estimate for possible savings in the sectors not covered by the Envirowise case studies. While the sectors covered are estimated to have possible savings of roughly £1,100 per employee, our cautious assumptions yield an estimate for those sectors not covered by Envirowise of only £225 per employee. As a result, the bulk of total savings (£1.8bn) come from the sectors covered by the Envirowise case studies. If the effective rate of savings per employee in the sectors not covered by Envirowise were as high as £1,100, the estimate of total potential savings in manufacturing industry in England and Wales would rise from £2.3bn to over £3.5bn.

**The range of possible outcomes**

The central estimate was tested for robustness and a plausibly wide range of outcomes was investigated by varying the assumptions for the annual savings per employee for the sectors not covered by case studies (see Table 3.1). The aim was to derive estimates of cost savings both on cautious assumptions, which yielded a low case of £2bn and, on more optimistic assumptions, which produced a high case of £2.9bn.

The range of cost savings of £2-2.9bn produced by this analysis represented, on a UK comparison, around 1¼-2% of manufacturing value added, or 5-7% of profits. This is a broad indication of the extent of saving that manufacturing businesses could achieve if the experience of firms in the Envirowise programmes were to be replicated elsewhere. Typically the average payback periods from waste minimisation process improvements, as indicated by the Envirowise case studies, were 12 months or less, suggesting that there was scope for quick wins for manufacturing businesses (see Appendix B Chart B2).



**TABLE 3.2: ANNUAL SAVINGS FROM WASTE MANAGEMENT PROCESS IMPROVEMENT IN MANUFACTURING IN ENGLAND AND WALES**

	SIC 92	Total net annual savings (£m 2000)	Total annual savings (£m 2000)	Total annual costs (£m 2000)
Food, drink and tobacco	15,16	339.2	407.7	68.5
Textiles, leather and clothing	17,18,19	231.4	232.5	1.1
Coke, petrol and nuclear fuels	23	5.2	5.6	0.4
Chemicals and man-made fibres	24	937.1	966.1	29.0
Basic metal and metal products	27,28	132.0	139.2	7.1
Engineering and allied industries	29-35	247.7	262.6	14.8
Other manufacturing	20-22,25-26,36-37	373.2	381.0	7.9
<b>Total</b>	<b>15-37</b>	<b>2265.8</b>	<b>2394.7</b>	<b>128.9</b>

Source(s) : CE, AEAT.

### 3.2 Results by broad manufacturing sector

Table 3.2 shows possible annual savings by broad manufacturing sector, alongside gross savings and gross costs. Chemicals and man-made fibres (£937m) accounts for just under one-half of total possible savings. It is estimated that all sectors other than coke, petrol and nuclear fuels could each make over £100m in savings. The estimate for coke, petrol and nuclear fuels is low partly because there is only one case study covering this sector and our method adopts a conservative approach in this case. But, this sector is characterised by the use of one primary input (coal, oil or other raw fuels) so waste is more identifiable and may already been minimised.

**CHART 3.2: DISTRIBUTION OF ANNUAL SAVINGS PER EMPLOYEE FROM ENVIROWISE CASE STUDIES**



Note(s) : Histogram includes only the 62 case studies which include data on employment.  
Source(s) : AEAT, CE.

**TABLE 3.3: SIZE DISTRIBUTION OF FIRMS IN ENVIROWISE CASE STUDIES**

	0-199	200-499	500-5000	5000+	Total
Food, Drink and Tobacco	3	0	3	0	6
Textiles, Leather and Clothing	3	5	2	0	10
Coke, Petrol and Nuclear Fuels	1	0	0	0	1
Chemicals and Man-Made Fibres	6	0	6	0	12
Basic Metal and Metal Products	9	2	0	0	11
Engineering and Allied Industries	3	5	4	0	12
Other Manufacturing	4	5	1	0	10
<b>Total</b>	<b>29</b>	<b>17</b>	<b>16</b>	<b>0</b>	<b>62</b>

Note(s) : The table covers only those case studies which included data on employment. There were 5 other case studies used formally in the calculations.

Source(s) : AEAT.

Chart 3.1 shows total savings by sector and savings as a percentage of estimated GVA by manufacturing sector in 2000. Savings in chemicals and man-made fibres are by far the highest as a percentage of GVA. Of the other sectors, the estimates for food, drink and tobacco and textiles clothing and leather are above the average (1.7% of GVA).

Chart 3.2 shows the distribution of annual savings per employee across the Envirowise case studies. These data were used to provide estimates of possible savings for sectors not covered by case studies. The chart shows that most data are grouped between £0 per employee and £500 per employee. We used the median of the range to estimate the savings in other sectors (see Appendix A: Methodology).

**TABLE 3.4: EMPLOYMENT COVERAGE OF ENVIROWISE CASE STUDIES**

	In case studies (‘000)	In GB in 2001 (‘000)	Case study as % of sector
Food, Drink and Tobacco	4.3	458.6	0.9
Textiles, Leather and Clothing	3.2	212.3	1.5
Coke, Petrol and Nuclear Fuels	0.1	26.1	0.3
Chemicals and Man-Made Fibres	7.2	230.1	3.1
Basic Metal and Metal Products	1.2	464.5	0.3
Engineering and Allied Industries	7.5	1146.6	0.7
Other Manufacturing	2.6	1065.1	0.2
<b>Total</b>	<b>26.1</b>	<b>3603.3</b>	<b>0.7</b>

Note(s) : The table covers only those case studies which included data on employment. There were 5 other case studies used formally in the calculations.

Source(s) : AEAT, ONS.

Table 3.3 shows the size distribution of firms in the case studies. Five of the seven broad sectors are covered by at least 10 case studies. Although the case studies cover no firms with more than 5,000 employees (or the data for these case studies were found to be unreliable), roughly one-quarter cover medium-sized firms (500-5,000 employees). Table 3.4 shows that the case studies cover roughly 0.7% of manufacturing industry by employment. Engineering and allied industries has the largest representation, with firms totalling 7,500 employees included, although chemicals and man-made fibres has the greatest coverage as a proportion of total sectoral employment.

**The net present  
value of possible  
savings**

The net present value of possible savings to manufacturing was also estimated during the course of this study. The methodology involved is described in Appendix A and results are given in Appendix B tables B4, B5, B6. These show that the estimated value to manufacturing is in the range £7.3bn to £11.9bn, depending on the lifetime of investments and the discount rate of the future stream of savings. Our central estimate is £8.9bn, assuming a discount rate of 10% and lifetime of 8 years for a long-term investment.

## 4 RESULTS OF GENERALISING THE ENVIROWISE CASE STUDIES BY REGION

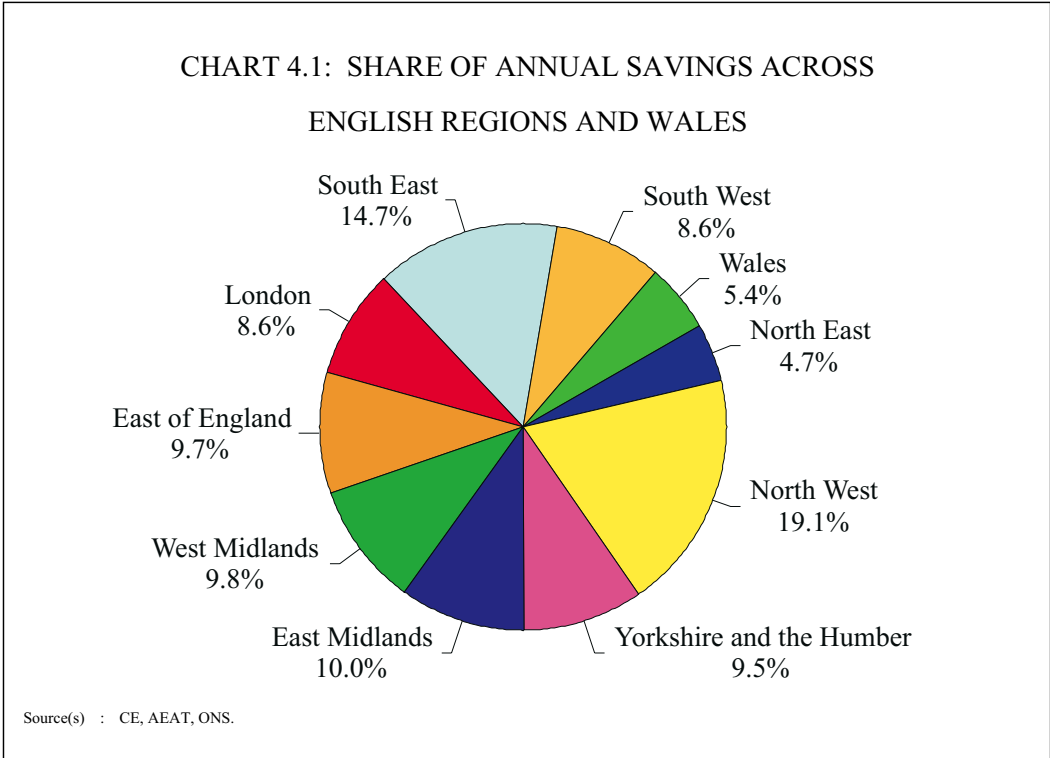
### 4.1 The key findings

Table 4.1 shows the estimated possible annual savings by English region and Wales, alongside the present value of gross savings and gross costs. Chart 4.1 shows the share of possible annual savings across English regions and Wales. These show that the North West and the South East have the largest possible savings; this is to be expected as these regions have the largest manufacturing GVA in England and Wales. The North East has the lowest, and it has the smallest manufacturing sector. Chart 4.2 shows net savings by region and as a percentage of estimated GVA for manufacturing in 2000. It shows that the North West and the South East also have the greatest possible savings as a percentage of GVA, reflecting the composition of manufacturing industry in these regions. Most other regions are close to the average for England and Wales. The West Midlands, which has a large manufacturing sector, has the lowest percentage.

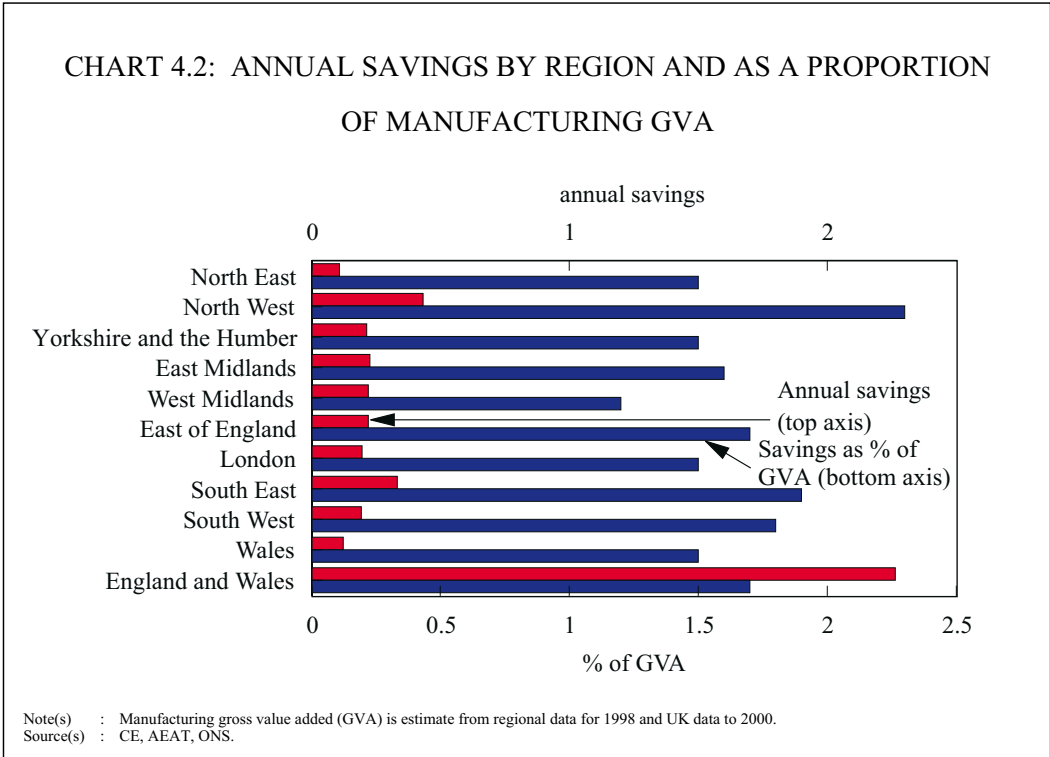
Because the case studies were not distinguished by region, and because the number of studies per region would in any case be too small, the regional breakdown has been obtained by allocating a proportion of possible savings on a pro-rata basis industry by industry according to each region's share in the GB total for employment. The industry definitions used for this allocation are quite detailed, but even so it is clear that these

**TABLE 4.1: ANNUAL SAVINGS IN CENTRAL CASE FROM WASTE MINIMISATION PROCESS IMPROVEMENT IN MANUFACTURING INDUSTRY - ENGLISH REGIONS AND WALES**

	Total net annual savings £m 2000 prices	Total annual savings £m 2000 prices	Total annual costs £m 2000 prices
North East	106.34	111.99	5.65
North West	431.79	454.60	22.81
Yorkshire and the Humber	215.05	224.64	9.59
East Midlands	227.21	238.43	11.22
West Midlands	221.03	238.65	17.63
East of England	219.28	229.32	10.04
London	195.94	205.04	9.10
South East	333.18	347.36	14.18
South West	193.77	214.84	21.07
Wales	122.24	129.81	7.57
England and Wales	2265.81	2394.68	128.87
Source(s) : CE, AEAT, ONS.			



estimates are indicative. They should be interpreted as representing an estimate of the geographical location of the industries in which the largest savings are to be found. It is estimated that just under half of total potential savings can be made in chemicals; as the North West and the South East have large chemicals industries these regions account for a proportionately large share of the potential savings.



## 5 MACROECONOMIC ESTIMATES OF THE COSTS OF UNPRODUCTIVE USE OF RESOURCES

---

### 5.1 The key findings

The potential savings that could arise from more productive use of resources come from a number of possible sources, as discussed in Section 2.1. The estimates presented in this chapter combine the estimates derived from the Envirowise case studies of manufacturing industry in Chapters 2 and 3 with other evidence. These data are subject to varying degrees of certainty. Our objective is to highlight:

- the wider significance, in terms of the potential benefits to the economy, of improving resource productivity
- the contribution that better resource efficiency can make to boosting UK productivity and competitiveness which is at the forefront of the Government's economic policy agenda

The findings, which follow broadly the ordering in Section 2.1 may be summarised as follows:

- The annual savings from improving resource productivity derived from the kind of waste minimisation covered in the Envirowise case studies of manufacturing industry are valued at £2.3bn. This represents around 1½% of UK manufacturing value added and about 5½% of its profits in 2000. This central estimate was tested for robustness and, in our judgement, a plausibly wide range for cost savings would be £2-2.9bn, equivalent to around 1¼-2% of UK manufacturing value added or 5-7% of the sector's profits in 2000. Typically the average payback periods from waste minimisation process improvements, in the Envirowise case studies, were twelve months or less, suggesting that there were ready opportunities for profitable courses of action by manufacturing businesses (see Appendix B Chart B2).
- There are also substantial gains in resource efficiency to be had from process improvements directed at raising in energy efficiency. Estimates by the Strategy Unit of the Cabinet Office suggest that some £1.4bn pa savings could be achieved by manufacturing industry, representing 18% of the total achievable by the economy (Cabinet Office, 2002). In the business sectors, the investments stimulated by Action Energy are estimated now to save over £800m annually, with a typical payback of two to four years.
- The non-manufacturing, predominantly service, sectors of the economy account for around four-fifths of the economy. The Strategy Unit estimates suggest that the annual savings from cost-effective energy efficiency measures from all sectors of the economy could total £7.3bn, with services contributing £1.2bn and transport £4.7bn. Their headline figure of £12.3bn annual saving, which has gained common currency, also includes the savings that could be realised by households.

## 6 RECOMMENDATIONS TO IMPROVE THE EVIDENCE BASE

---

Our study has highlighted the importance of resource productivity and the benefits that businesses could gain from minimising waste and using resources more efficiently in productive processes. However the analysis has also encountered problems with the quality of data. It is therefore recommended that further work be undertaken that improves the quality of the estimates as follows:

- The coverage of the Envirowise studies should be extended beyond the current position in which around a half of manufacturing employment is covered by sectors for which there are case studies.
- The Envirowise (and any similar programme) should promote the use of key performance indicators for resource productivity and measurement in order to determine more accurately the cost of unproductive use of resources to businesses. The case studies should include, for example, data on the environmental impact of resource productivity improvements, measured in physical terms as the reduction in tonnes of waste. It would also be helpful if a standard methodology for measuring the value of the firm's processing costs embodied in its waste was explored.
- As the manufacturing now accounts for only around a fifth of the economy's value added, the scope of environmental studies should be extended to sectors beyond manufacturing.

## 7 REFERENCES

---

- Cabinet Office (2001), *Resource Productivity: Making More With Less*, Performance and Innovation Unit Report, November.
- Cabinet Office (2002), *The Energy Review*, Performance and Innovation Unit Report, February.
- DTI (2003), *Energy White Paper: Our energy future - creating a low carbon economy*, February.
- Goldstein D (2002), *Theoretical perspectives on strategic environmental management*, Journal of Evolutionary Economics; Volume 12, Issue 5, pp 495-527.
- HMT (2003), *Chancellor's Budget Statement 2003*, April.
- HMT (2003), *Budget 2003*, April.
- Oakdene Hollins (2002), *Bedfordshire Waste Reduction in Industry Project*, Oakdene Hollins, September, [www.oakdenehollins.co.uk](http://www.oakdenehollins.co.uk).
- Oakdene Hollins (2003), *Data supplied via e mail by Peter Lee*, April.
- ONS (2002), *United Kingdom National Accounts 2002, The Blue Book*, National Statistics.

**APPENDIX A**  
**METHODOLOGY FOR DERIVING**  
**ESTIMATES FROM THE ENVIROWISE**  
**CASE STUDIES**

## A1.1 Introduction

A brief summary of the methodology is given Chapter 2. This appendix describes the methodology in detail.

## A1.2 Methodology

**Data sources** Envirowise provided all the case study data. Other data were used to extrapolate these to regional and sectoral totals: employment data from NOMIS and data on turnover from ABI.

**Processing the case studies** The Envirowise dataset had to be reworked in several ways. First, the case studies covered the years 1995-99, whereas our estimates are in 2000 prices. We therefore scaled up all monetary values in the case studies by the UK GDP deflator. Second, some of the case studies did not contain enough detail or contained the wrong kind of data; for example two case studies contained data on the firm's global employment, whereas we required GB employment. We removed these case studies from the calculation.

**Calculating the savings for the firm** The firm's savings are identified as net annual savings: gross annual savings minus gross annual operating costs. The investment required and one-off savings are not included in the calculation of annual savings. We present separately estimates of the payback period and net present value of the investments.

**Calculating the savings for the group** Each case study is assigned an SIC 92 group (eg 15.1)<sup>1</sup>. Given the savings from a given case study, we estimated the untapped annual savings for the group using the following formula:

$$GS = \sum_{i=1}^n \left( \frac{EI - EC_i}{EC_i} \times R_i \times S_i \right)$$

where: GS = savings for the group, n = the number of case studies in the group, EI = group employment, EC = employment<sup>2</sup> in the case study, R = the replication rate across the group, S = annual savings for the firm.

As each case study covers a different technique or a different group, we could sum the value of investments without fear of double counting. The replication rate is the extent to which the technique could be copied across the sector, combining the proportion of firms this technique applies to and how widely the technique has already been implemented.

Having obtained the value of possible savings to a group, we calculated the regional values by splitting these savings according to regional shares of employment.

1 'Group' is the term for a 3-digit SIC code. Case studies were also provided at the division (2-digit) and class (4-digit) level.

2 Calculations for some of the case studies were based on turnover data because data on employment were unavailable.

**Calculating the savings for the subsection**

The sectors covered by case studies cover roughly half of manufacturing (by employment); the remaining proportion of manufacturing therefore needed to be accounted for. We assume that the missing groups offer less scope for savings, on the grounds that they would probably otherwise have been highlighted as candidates for a case study. This is a cautious assumption; since participants in the case studies are typically more environmentally aware, it may be argued that those not covered by studies have greater potential savings to make. We could not use the data sensibly to identify the waste-saving possibilities of each subsection individually, as most subsections contain few case studies. As this is the part of the calculation with the most uncertainty, we calculated a range of values for savings for the missing groups, using the following formula:

$$S = Q_i \times UE$$

where S is the savings in the undetermined part of the subsection, UE is employment in the undetermined part of the subsection and Q is each of the lower quartile, median and upper quartile of the distribution of the following statistic calculated from the case studies:

$$\frac{AS \times R}{E}$$

where AS is annual savings for the firm, R is the replicability of the process improvement and E is the employment in the firm.

**Identifying the source of the savings**

One of the main purposes of the project is to discover what proportion of net savings comes from, say, the reduction of raw inputs, compared to the proportion coming from reduced waste disposal costs. As operating costs are not identified on the same basis as savings, we calculate these proportions as proportions of gross savings.

**Calculation of net present values of savings**

Often (but not always), an outlay of investment is required to achieve the savings. In order to quantify the value of possible savings to manufacturing given this outlay, we calculated the net present value (NPV) of all future and immediate savings and costs. The NPVs for each firm were calculated using the following formula:

$$NPV = \sum_{t=1}^n \frac{S - C}{(1 + r)^t} - I$$

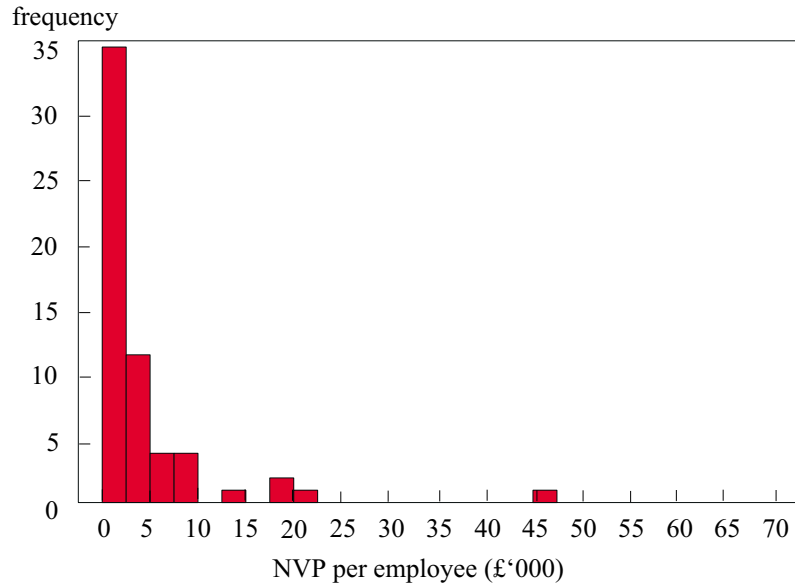
where: NPV = net present value of the investment to the firm, n = lifetime of the investment, S = gross annual savings from the investment, C = gross increase in annual operating costs, r = real discount rate, I = investment costs.

Savings and operating costs are assumed to be constant in real terms over the lifetime of the investment. The discount rate is intended to reflect the long-term average opportunity cost of capital to UK manufacturers.

Our method for extrapolating these savings to the rest of manufacturing was virtually identical to that for annual savings. The only difference was that we used the median of net savings per employee (after adjustment for replicability) for all our calculations. We created a range of values by varying assumptions on the lifetime of the projects and the discount rate of the future stream of revenues.

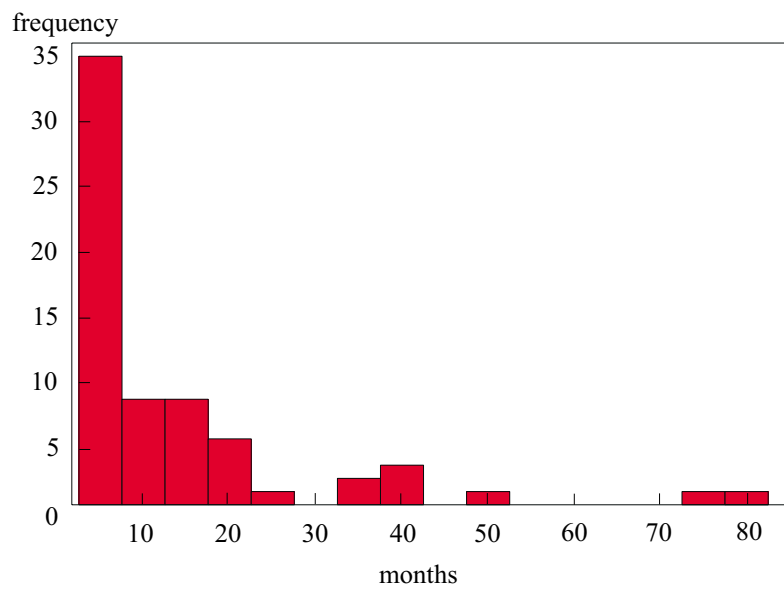
**APPENDIX B**  
**SUPPLEMENTARY TABLES**  
**AND CHARTS**

**CHART B1: DISTRIBUTION OF NET PRESENT VALUE OF SAVINGS PER EMPLOYEE FROM ENVIROWISE CASE STUDIES**



Note(s) : Histogram includes only the 61 case studies which include data on employment. NPV calculated using a real discount rate of 15%.  
 Source(s) : AEAT, CE.

**CHART B2: DISTRIBUTION OF PAYBACK PERIODS FROM ENVIROWISE CASE STUDIES**



Source(s) : AEAT, CE.

**TABLE B1: BREAKDOWN OF ANNUAL SAVINGS FROM WASTE MINIMISATION PROCESS IMPROVEMENT IN CENTRAL CASE - MANUFACTURING SECTORS**

	Costs (£m 2000 prices)			Savings (£m 2000 prices)		Investment required (£m 2000 prices)	
	Gross operating costs	Reduced use of raw inputs	Reduced costs from substitution	Reduced waste disposal costs	Other savings		Total savings
Food, drink and tobacco	68.5	67.0	7.2	30.5	303.1	407.7	379.9
Textiles, leather and clothing	1.1	217.4	2.2	5.7	7.2	232.5	101.4
Coke, petrol and nuclear fuels	0.4	4.2	0.1	0.3	0.9	5.6	3.5
Chemicals and man-made fibres	29.0	565.8	59.6	156.5	184.3	966.1	574.6
Basic metal and metal products	7.1	73.7	0.6	13.0	51.9	139.2	128.8
Engineering and allied industries	14.8	211.1	3.8	15.2	32.6	262.6	145.5
Other manufacturing	7.9	284.4	8.9	28.7	59.1	381.0	177.8
<b>Total</b>	<b>128.9</b>	<b>1423.4</b>	<b>82.3</b>	<b>249.9</b>	<b>639.1</b>	<b>2394.7</b>	<b>1511.5</b>

Note(s) : Investment costs are net of one-off savings.

Source(s) : CE, AEAT, ONS.

**TABLE B2: BREAKDOWN OF ANNUAL SAVINGS FROM WASTE MINIMISATION PROCESS IMPROVEMENT IN UK MANUFACTURING INDUSTRY - ENGLISH REGIONS AND WALES**

	Costs (£m 2000 prices)			Savings (£m 2000 prices)		Investment (£m 2000 prices)	
	Gross operating costs	Reduced use of raw inputs	Reduced costs from substitution	Reduced waste disposal costs	Other savings		Total savings
North East	5.7	68.1	4.1	12.1	27.7	112.0	70.1
North West	22.8	275.6	16.9	47.9	114.3	454.6	284.8
Yorkshire and the Humber	9.6	141.0	7.4	23.7	52.5	224.6	141.6
East Midlands	11.2	142.4	8.5	26.6	61.0	238.4	148.2
West Midlands	17.6	141.7	5.0	18.7	73.4	238.7	162.7
East of England	10.0	139.8	8.8	27.9	52.9	229.3	137.5
London	9.1	129.6	6.8	21.0	47.6	205.0	115.5
South East	14.2	210.4	15.3	43.4	78.3	347.4	209.7
South West	21.1	99.3	5.3	16.4	93.9	214.8	161.9
Wales	7.6	75.6	4.3	12.2	37.6	129.8	82.5
England and Wales	128.9	1423.4	82.3	249.9	639.1	2394.7	1511.5

Note(s) : Investment costs are net of one-off savings.

Source(s) : CE, AEAT, ONS.

**TABLE B3: WASTE ARISING ACROSS WASTE PRODUCING SECTORS - ENGLISH REGIONS AND WALES**

	Industrial	Commercial	Special	Construction and demolition	Agricultural	Municipal	Mining and Mineral	Other	Total
East of England	3.7	2.5	1.0	7.2	5.4	2.9	1.5	0.2	20.6
East Midlands	5.9	1.8	0.4	6.1	5.3	2.3	35.6	0.2	51.7
London	2.7	4.4	0.0	6.6	0.1	4.4	0.0	0.3	15.7
North East	3.8	1.0	0.2	4.8	2.1	1.5	20.3	0.1	30.0
North West	6.5	3.1	0.8	10.2	8.0	4.1	3.8	0.3	30.3
South East	5.0	4.0	0.5	13.1	5.0	4.3	6.0	0.3	33.3
South West	2.9	2.3	0.3	6.8	14.5	2.6	30.3	0.2	57.0
Wales	5.0	1.1	0.4	3.3	8.4	1.6	22.0	0.2	37.1
West Midlands	5.2	2.3	0.6	6.3	6.8	2.9	12.6	0.2	31.8
Yorkshire & the Humber	9.5	2.2	0.6	8.1	7.3	2.8	75.8	0.3	97.3
Total	50.1	24.8	4.9	72.5	62.9	29.3	257.5	2.3	454.3

Note(s) : Data are for 1998/9 except municipal waste, which is for 1999/2000. 'Other' includes sewage sludge and forestry, fishing and other priority wastes. 'Special' includes hazardous or toxic wastes. Source(s) : AEA: "Key industrial environmental pressures - data on waste arisings" August 2002.

**TABLE B4: NET PRESENT VALUE OF SAVINGS FROM WASTE MANAGEMENT PROCESS IMPROVEMENTS IN MANUFACTURING IN ENGLAND AND WALES - SENSITIVITY TO ALTERNATIVE ASSUMPTIONS**

	Low	Central	High
	£bn 2000		
Costs	2.0	2.1	2.3
Savings	9.3	11.1	14.3
Net savings	7.3	8.9	11.9

Note(s) : Variation of assumptions: Low: 12.5% discount rate, 7 years lifetime for a long-term investment; Central: 10% discount rate, 8 years lifetime for a long-term investment; High: 7.5% discount rate, 10 years lifetime for a long-term investment.

Source(s) : CE, AEAT, ONS.

**TABLE B5: NET PRESENT VALUE OF SAVINGS FROM WASTE MANAGEMENT PROCESS IMPROVEMENTS IN MANUFACTURING IN ENGLAND AND WALES AS A PERCENTAGE OF SECTORAL GVA**

	SIC 92	NPV of savings £bn 2000 prices	GVA (E&W) £bn 2000 prices	Savings as % of GVA
Food, Drink and Tobacco	15,16	1.3	17.1	7.6
Textiles, Leather and Clothing	17,18,19	1.1	5.7	19.2
Coke, Petrol and Nuclear Fuels	23	0.0	2.2	0.1
Chemicals and Man-Made Fibres	24	3.5	14.6	24.0
Basic Metal and Metal Products	27,28	0.3	14.1	2.3
Engineering and Allied Industries	29-35	1.0	43.9	2.2
Other Manufacturing	20-22,25-26,36-37	1.6	37.7	4.3
Manufacturing	15-37	8.9	135.2	6.7

Note(s) : Gross value added (GVA) in England and Wales is estimated from regional data for 1998 and UK data to 2000.

Source(s) : CE, AEAT, ONS.

**TABLE B6: NET PRESENT VALUE OF SAVINGS FROM WASTE MANAGEMENT PROCESS IMPROVEMENT IN MANUFACTURING IN ENGLAND AND WALES**

	SIC 92	Total NPV (£bn 2000 prices)	Total Savings (£bn 2000 prices)	Total Costs (£bn 2000 prices)
Food, drink and tobacco	15,16	1.33	2.06	0.73
Textiles, leather and clothing	17,18,19	1.10	1.20	0.10
Coke, petrol and nuclear fuels	23	0.02	0.03	0.01
Chemicals and man-made fibres	24	3.50	4.22	0.73
Basic metal and metal products	27,28	0.32	0.48	0.16
Engineering and allied industries	29-35	1.04	1.25	0.21
Other manufacturing	20-22,25-26,36-37	1.61	1.80	0.20
Total	15-37	8.91	11.05	2.14

Source(s) : CE, AEAT.